Double Side paper - Banks

TREATMENT OF ALLERGIC RHINITIS

The present invention relates to the discovery that various proteins isolated from ticks are effective in the treatment and prevention of allergic rhinitis. These proteins may most suitably be applied to an affected area and are effective to treat this condition and to ameliorate its symptoms.

Allergic rhinitis is the medical term given to the inflammation of the nasal mucosa caused by allergens such as pollen or dust. There are two general types of allergic rhinitis, seasonal and perennial. Seasonal allergic rhinitis is normally referred to as hay fever and is usually caused by mould or pollen. Perennial allergic rhinitis is usually caused by an inherent sensitivity to one or more types of allergen. This condition generally continues throughout the year or for as long as the patient is exposed to the allergen. The condition is thought to affect more than 15% of the population of the western world.

Both types of allergic rhinitis involve a type 1 (IgE-mediated) hypersensitivity that leads to inflammation. This inflammation is thought to be caused by an excessive degranulation of mast cells and of blood-borne basophils in response to certain allergens. This leads to increased IgE levels and the concomitant release of inflammatory mediators, such as histamine, and of chemotactic factors, such as cytokines, prostaglandins and leukotrienes, that result in a localised inflammatory reaction.

In many cases, prevention of allergic rhinitis can be maximised by avoiding contact with the causative allergen, since even the best medical therapies currently available are ineffective in the face of a high allergen load. However, this is not always possible or practical.

A number of interventional approaches are widely used, including the use of intranasal vasoconstrictors, intranasal and systemic antihistamines, intranasal glucocorticoids, mast cell stabilisers, such as cromolyn compounds, and oral decongestants. One problem with some of the more well-established treatments is that they have a sedative effect, so causing a decrease in patient performance, alertness and cognitive function. Although some non-sedating histamine H1 antagonists are now available, there is a great need for the identification of other non-sedative agents that are effective in the treatment of this condition.

Conventional H_1 receptor antagonists are widely used as antihistamine agents for treating allergic reactions including allergic rhinitis (hay fever), urticaria, insect bites and drug hypersensitivities. H_1 receptor antagonists target the redness and inflammation that is associated with these conditions. However, there are numerous undesirable effects of the H_1 receptor antagonists currently used. When used for purely antihistamine actions, all of the effects on the central nervous system (CNS) are unwanted. When used for their sedative or anti-emetic actions, some of the CNS effects such as dizziness, tinnitus and fatigue are unwanted. Excessive doses can cause excitation and may produce convulsions in children. The peripheral anti-muscarinic actions are always undesirable. The commonest of these is dryness of the mouth, but blurred vision, constipation and retention of urine can also occur. Unwanted effects not related to the drug's pharmaceutical action are also seen. Thus, gastrointestinal disturbances are fairly common while allergic dermatitis can follow topical application of these drugs.

H_2 receptor antagonists are also used as antihistamine agents. These agents target the itching that is associated with the condition as a result of activation of certain aspects of the nervous system.

It can therefore be seen that drugs used to control the actions of histamine are not always effective. The reasons why they may have limited efficacy may relate to the specificity of these drugs for only a sub-class of histamine receptors, particularly when a certain class of conditions requires interference with a larger class of receptors. Indeed, it is now known that there are a large number of different chemoattractants and vasoactive substances implicated in allergic rhinitis, liberated not only by mast cells but also by eosinophils and other cells, that produce undesirable symptoms in patients with allergic disorders.

There is thus a great need for agents that are effective in ameliorating the symptoms of this condition, but that do not generate the side-effects that detract from their attractiveness as therapeutic compounds.

Molecules that are capable of binding to histamine have previously been identified in blood-feeding ectoparasites, such as ticks. For example, a salivary nitric oxide–carrying haeme protein (nitrophorin) of the triatome bug *Rhodnius prolixus* has been found to bind histamine (Ribeiro & Walker, 1994). The isolation of a family of vasoactive amine binding proteins from ticks is described in co-pending International Patent Application No. PCT/GB97/01372, owned by the Applicant for the present invention. The contents of this

application are incorporated into the present application in their entirety. These proteins bind to histamine and are closely related to one another. Some of these molecules also bind to serotonin. These molecules differ markedly from any of the H_1, H_2 or H_3 receptor families and appear to bind to histamine in a different manner.

The present invention is based on the discovery that these tick proteins, and molecules based on their structure, are effective in the treatment of allergic rhinitis.

Summary of the Invention

According to the present invention there is provided the use of a histacalin protein in the manufacture of a medicament for the treatment or prevention of allergic rhinitis.

The present invention also provides a method for the treatment or prevention of allergic rhinitis which comprises administering to a subject an effective amount of a histacalin protein.

The term "histacalin protein" in the present application denotes:

(a) any vasoactive amine binding protein that binds specifically to a vasoactive amine with a dissociation constant of less than 10^{-7}M and which belongs to the same protein family as the proteins MS-HBP1, FS-HBP1 and FS-HBP-2 disclosed in co-pending International Patent Application No. PCT/GB97/01372 wherein a protein is considered to belong to this protein family if the primary, mature monomer sequence of the protein has no more than 260 amino acids and at least 30 of the amino acids in the protein's complete sequence are conserved as identical residues in an alignment of that protein and the proteins MS-HBP1, FS-HBP1 and FS-HBP-2, the alignment preferably having been obtained using GCG's pileup command (Program Manual for the Wisconsin Package, 1994; gap creating penalty = 3; gap extension penalty = 1, scoring matrix Blosum62.cmp, pileup carried out using the endweight option);

(b) a protein from a haematophagous arthropod that binds specifically to histamine with a dissociation constant less than 10^{-7} M and which contains the sequence motifs D/E A W K/R (preferably DAWK, more preferably QDAWK) and Y/C E/D L/I/F W (preferably Y/C ELW);

(c) a natural biological variant, such as an allelic variant or a geographical variant, of a protein as defined in (a) or (b) above;

(d) a functional equivalent of a protein as defined in (a), (b) or (c) above that contains single or multiple amino-acid substitution(s), addition(s), insertion(s) and/or deletion(s) from the wild type protein sequence and/or substitutions of chemically-modified amino acids that do not affect the biological function of binding to its respective vasoactive amine;

(e) an active fragment of a protein as defined in (a), (b), (c) or (d) above, wherein "active fragment" denotes a truncated protein that retains the biological function of binding to its respective vasoactive amine; and

(f) a fusion protein comprising a protein as defined in (a), (b), (c), (d) or (e) above fused to a peptide or other protein, such as a label, which may be, for instance, bioactive, radioactive, enzymatic or fluorescent, or an antibody.

An alignment of the proteins MS-HBP1, FS-HBP1 and FS-HBP-2 obtained using GCG's pileup command (Program Manual for the Wisconsin Package, 1994; gap creating penalty = 3; gap extension penalty = 1, scoring matrix Blosum62.cmp, pileup carried out using the endweight option) is shown in Table 1 below.

TABLE 1

SEQUENCE COMPARISON OF FS-HBP1 (top line), FS-HBP2 (middle line) and MS-HBP1 (bottom line). Identical residues are marked "=" below the three lines of sequence. The sequences were aligned as described above

D	K	P	V	W	A	D	E	A	A	N	G	E	H	Q	D	A	w	K	H
N	Q	P	D	W	A	D	E	A	A	N	G	A	H	Q	D	A	W	K	S
N		P	T	W	A	N	E	A	K	L	G	S	Y	Q	D	A	W	K	S
		=		=	=		=	=			=			=	=	=	=	=	
L	Q	K	L	V	E	E	N			Y	D	L	I	K	A	T	Y	K	N
L	K	A	D	V		E	N	V		Y	Y	M	V	K	A	T	Y	K	N
L	Q	Q			D	Q	N	K	R	Y	Y	L	A	Q	A	T	Q	T	T
=							=			=					=	=			

D	P	V	W	G	N	D	F	T	C	V	G	T	A	A	Q	N	L	N	E
D	P	V	W	G	N	D	F	T	C	V	G	V	M	A	N	D	V	N	E
D	G	V	W	G	E	E	F	T	C	V	S	V	T	A	E	K	I	G	
=		=	=	=			=	=	=	=				=					
D	E	K	N	V	E	A	W	F	M	F	M	N	N	A	D	T	V	Y	Q
D	E	K	S	I	Q	A	E	F	L	F	M	N	N	A	D	T	N	M	Q
	K	K	K	L	N	A	T	I	L	Y	K	N	K	H	L	T	D	L	K
		=				=						=				=			
H	T	F	E	K	A	T	P	D	K	M	Y	G	Y	N	K	E	N	A	I
F	A	T	E	K	V	T	A	V	K	M	Y	G	Y	N	R	E	N	A	F
E	S	H	E	T	I	T	V	W	K	A	Y	D	Y	T	T	E	N	G	I
			=			=			=		=		=			=	=		
T	Y	Q	T	E	D	G				Q	V	L	T	D	V	L	A	F	S
R	Y	E	T	E	D	G				Q	V	F	T	D	V	I	A	Y	S
K	Y	E	T	Q		G	T	R	T	Q	T	F	E	D	V	F	V	F	S
	=		=			=				=				=	=				=
D		D	N	C	Y	V	I	Y	A	L	G	P	D	G	S	G	A	G	
D		D	N	C	D	V	I	Y	V	P	G	T	D	G	N	E	E	G	
D	Y	K	N	C	D	V	I	F	V	P	K	E	R	G	S	D	E	G	D
=			=	=		=	=							=				=	
Y	E	L	W	A	T		D		Y	T	D	V	P	A	S	C	L	E	K
Y	E	L	W	T	T		D		Y	D	N	I	P	A	N	C	L	N	K
Y	E	L	W	V	S	E	D	K	I	D	K	I	P		D	C	C		K
=	=	=	=				=						=			=			=

F	N		E	Y		A	A	G	L	P			V	R	D	V	Y	T	
F	N		E	Y		A	V	G	R	E			T	R	D	V	F	T	
F	T	M	A	Y	F	A	Q	Q	Q	E	K	T	V	R	N	V	Y	T	D
=				=		=								=		=		=	
S	D	C	L	P					E										
S	A	C	L						E										
S	S	C	K	P	A	P	A	Q	N										
=		=																	

Preferably, a protein is in the same family as the above proteins if it contains more than 40, more preferably more than 50, more preferably more than 60 residues, most preferably 70 residues or more which are identical as defined in a) above when aligned with the proteins shown in Table 1.

Preferably, the histacalin protein is derived from a blood-feeding ectoparasite, such as a leech, mosquito or tick. Most preferably, the histacalin protein is derived from a tick, in particular a species of hard tick such as *R. appendiculatus*, *I . ricinus* and *D. reticulatus.*

Preferably, a histacalin protein as defined in (a) above has at least 50%, more preferably at least 60% and most preferably 70% or more amino acid residues conserved as identical residues in an alignment of that protein with the proteins MS-HBP1, FS-HBP1 and FS-HBP2.

Preferably, a pharmaceutically-acceptable carrier is also used in the manufacture of the medicament according to the invention. Such a pharmaceutically-acceptable carrier is also preferably used in the method of the present invention.

Suitable pharmaceutically-acceptable carriers include carriers that do not themselves induce the production of antibodies that are harmful to the individual receiving the composition. Typically, suitable carriers are large, slowly metabolised macromolecules such as proteins, polysaccharides, polylactic acids, polyglycolic acids, polymeric amino

acids, amino acid copolymers, lipid aggregates (such as oil droplets or liposomes) and inactive virus particles. Such carriers are well known to those of skill in the art.

Pharmaceutically-acceptable carriers in therapeutic compositions may also contain liquids such as water, saline, glycerol and ethanol. Additionally, auxiliary substances, such as wetting or emulsifying agents and pH buffering substances, may be present.

Optionally, one or more other, conventional antihistamine agents or anti-sedative agents may also be used in the manufacture of the medicament according to the invention. Such conventional antihistamine agents or anti-sedative agents may also be used in the method of the present invention. The inclusion of these agents allows a synergistic effect on allergic rhinitis.

Sometimes conventional antihistamine agents provide unwanted side-effects, such as drowsiness. In this eventuality, it may be advantageous to further include one or more anti-sedative agents in the manufacture of the medicament and in the method. Suitable anti-sedative agents are well known to those of skill in the art.

The histacalin proteins described above may be used for the treatment of any condition of allergic rhinitis. This term is meant to include both seasonal and perennial allergic rhinitis.

Treatment may be occasional, for example in the case of seasonal allergic rhinitis. The patient may in these cases apply the histacalin protein only when symptoms of allergic rhinitis appear or are likely to appear, for example, during conditions of high atmospheric pollen content.

Any mammalian patient is suitable for treatment by the method of the present invention. Preferably, the patient is human.

Patients who suffer from perennial allergic rhinitis may need to apply the histacalin protein continuously as a preventative measure. In order to ensure the application of an effective dose, the patient may need to apply the histacalin protein once, twice, three times or even four times daily.

The histacalin protein may be administered topically to the affected area by intra-nasal drops or aerosol spray or systemically by oral administration, such as in capsules or cartridges, or by injection.

Preferably, the histacalin proteins will be applied intranasally, in order that the nasal mucosa are exposed to them. The most suitable form of medicament for intranasal administration is generally an aerosol spray, examples of which may be found in the art (see, for example British National Formulary No. 37, March 1999: Drugs used in nasal allergy). The histacalin protein should be diluted in a suitable pharmaceutical carrier such as water or saline. Preferably, physiological saline, pH 7.2, is used.

The effective dose for a given treatment can be determined by routine experimentation and is within the judgement of the skilled person. For example, in order to formulate a range of dosage values, cell culture assays and animal studies can be used. The dosage of such compounds preferably lies within the dose that is therapeutically effective in 50% of the population, and that exhibits little or no toxicity at this level. For the purposes of the present invention, the term "therapeutically-effective" means that it produces a clinically significant reduction in nasal airway resistance and/or a reduction in the quantity of nasal mucus and/or a reduction in nasal pruritus.

For the purposes of the present invention, an effective dose is considered to be between 0.01 μg/ kg and 50 μg/kg or, more typically, between 0.05 μg/kg and 10 μg/kg of the individual to which it is administered.

Preferably, for intranasal administration, the histacalin proteins are present in solution at between 0.1μg/ml and 100μg/ml, preferably between 0.1 μg/ml and 10μg/ml, more preferably between 1μg/ml and 8μg/ml.

Various aspects and embodiments of the present invention will now be described in more detail by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a table of the data obtained for three volunteer subjects relating to nasal secretions;

Figure 2 shows a table of the data obtained for three volunteer subjects relating to nasal airway resistance:

Figures 3a, 3b and 3c show the data for nasal secretions in graphical form for each individual subject; and

Figures 4a, 4b and 4c show the data for nasal airway resistance in graphical form for each individual subject.

It will be appreciated that modification of detail may be made without departing from the scope of the invention.

EXAMPLE

In this study, three subjects were challenged intranasally with histamine. The histamine concentrations used were 0.5 mg/ml, 1.0 mg/ml, 2.0 mg/ml, 4.0 mg/ml and, where necessary to achieve a 100% or greater increase in nasal airway resistance on the pre-treatment challenge, 8 mg/ml. One hundred microlitres of each dose was administered to each nostril for each challenge.

Initially, baseline measurements were taken of the subjects' anterior nasal secretions. Nasal secretions were measured by asking subjects to blow their noses into pre-weighed paper handkerchiefs and then re-weighing them to calculate the weight of secretions produced.

Each subject was then administered with a nasal histamine dose-response challenge. 45 minutes after the completion of the challenge, baseline measurements were repeated. Then a histacalin protein, EV504, was administered as a fresh solution of pre-weighed aliquots of histacalin in phosphate buffered saline. The solution was administered by dropping from a pipette into each nostril.

EV504 is an internal designation for the histamine binding protein MS-HBP1 described in PCT/GB97/01372. In the attached Figures it is referred to as VAC life or Histamine binding protein.

After a further 15 minutes, a repeat nasal histamine dose-response challenge was administered. The outcome measurements are recorded as total nasal airway resistance, as measured by active posterior rhinomanometry (placing inflatable balloons in the posterior nares and monitoring changes in pressure and volume), and by measurement of anterior nasal secretions, as measured by weight of expelled secretions. The anterior nasal secretions are represented as a cumulative total for the histamine challenges. These measurements are shown in Figures 1, 3a, 3b and 3c.

For Figures 2, 4a, 4b and 4c, the nasal airway resistance measured has been represented as a percent change from a saline challenge response (undertaken as the first challenge in the histamine dose-response challenge).